

Organic Geochemistry of the Hamersley Province: Relationships among organic carbon isotopes, molecular fossils, and lithology

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Molecular fossils are particularly valuable ancient biosignatures that can provide key insight about microbial sources and ecology in early Earth studies. In particular, hopanes carrying 2-methyl or 3-methyl substituents are proposed to be derived from cyanobacteria and oxygen-respiring methanotrophs, respectively, based on both their modern occurrences and their Proterozoic and Phanerozoic sedimentary distributions. Steranes are likely from ancestral eukaryotes. The distribution of methylhopanes, steranes, and other biomarkers in 2.72–2.56 billion-year-old rocks from the Hamersley Province, Western Australia show relationships to lithology, facies, and isotopes of macromolecular carbon, and other biomarkers. These observations support biomarker syngenicity and thermal maturity. Moreover, ecological signatures are revealed, including a surprising relationship between isotopic values for bulk macromolecular carbon and the biomarker for methanotrophs. The record suggests that cyanobacteria were likely key organisms of shallow-water microbial ecosystems providing molecular oxygen, fixed carbon, and possibly fixed nitrogen, and methanotrophs were not alone in recycling methane and other ^{13}C -depleted substrates.